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(54) A CURABLE ETHYLENE-ALKYL ACRYLATE COPOLYMER COMPOSITION CONTAINING SILANE TREATED ALUMINUM OXIDE FILLER

(71) We, UNION CARBIDE CORPORATION, a Corporation organised and existing under the laws of the State of New York, United States of America, of 270 Park Avenue, New York, State of New York, 10017, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a curable composition for electrical insulation based on ethylene - alkyl acrylate copolymer containing hydrated aluminum oxide filler treated with at least one silane.

Insulation compositions which are employed on electrical wire and cable are, in many cases, prepared from compositions based on vulcanizable, or cross-linked, ethylene polymers.

United States Patent No 3,832,326 describes crosslinkable ethylene-vinyl acetate copolymer compositions containing silane-treated hydrated inorganic fillers, particularly hydrated aluminum oxide. These copolymer compositions are used for coating electrical conductors such as building wire and appliance and automotive wire to provide improved heat resistance and flame retardance.

However, in coating applications such as appliance and automotive wire the insulation must be flexible since the cable may be attached to moving parts. The ethylene-vinyl acetate copolymer-based coating compositions of the prior art may not possess the required flexibility for suitable appliance and automotive wire applications.

Also, in order to process ethylene copolymer-based compositions so as to adapt them to be placed, as insulation, on the electrical conductor components of the wire and cable it is usually necessary to admix the components of the compositions at high temperatures, and to extrude them, again at high temperatures, on to the electrical conductor. When certain fillers are used in combination with ethylene copolymer-based compositions, the entire curable composition is susceptible to scorching during the high temperature processing thereof prior to the vulcanization of the composition on the electrical conductor. Scorching is, in effect, the premature vulcanization of the insulation composition. This premature vulcanization usually takes place in the barrel or die head of the extruder in which the insulation composition is being processed, at elevated temperatures, prior to its being extruded onto an electrical conductor, and prior to its intended vulcanization. When an insulation composition is scorched in the extruder, the extruder composition will have imperfections in the form of discontinuity and roughness in the surface of the insulation and lumps or surface ripples caused by gel particles in the body of the extrudate. In addition, excessive scorching may cause sufficient pressure build-up in the extrusion device to require a cessation of the extrusion operation entirely.

Also, another important property that an insulated appliance or automotive wire should possess is that it be pinch resistant. This means that when a wire is surrounded by a clamp, the insulation around the wire must withstand the pinching force of the clamp.

It has now been found that curable ethylene-alkyl acrylate copolymer-based composi-

tions which employ hydrated aluminum oxide fillers treated with at least one silane provide several advantages, over previously available compositions, such as increased flexibility and scorch resistant electrical insulation.

In accordance with the present invention there is provided a curable composition suitable for electrical coating applications comprising an ethylene-alkyl acrylate (as hereinafter defined) copolymer and a hydrated aluminum oxide treated with at least one silane of the following formula:

$$R_aSiX_{4-a}$$

wherein R is a lower alkyl, lower alkenyl or lower alkynyl group (the term "lower" being as hereinafter defined), X is an alkoxy or alkoxyalkoxy group containing from 1 to 20 carbon atoms, and *a* is 1 or 2.

One preferred embodiment of the curable compositions of the present invention comprises:

the ethylene-alkyl acrylate copolymer; and from 80 to 400 parts by weight, preferably from 100 to 150 parts by weight, per 100 parts by weight of the ethylene-alkyl acrylate copolymer, of hydrated aluminum oxide filler treated with from 0.5 to 5.0 parts by weight, preferably from 1.0 to 3.0 parts by weight, per 100 parts by weight of the filler, of at least one of the recited silanes.

The copolymer used in the present invention comprise units corresponding to ethylene and an alkyl acrylate. By "alkyl acrylate" for the purpose of this invention is meant an alkyl ester of an acrylic acid, as defined in Acrylic Resins, by Milton B. Horn, p. 15f., under the subtitle "Monomer Chemistry", whereunder alkyl esters of both unsubstituted acrylic acid

$$(CH_2{=}CH{-}COOH)$$

and simple alpha-substituted acrylic acids such as those acrylic acids having a lower alkyl substituent, e.g., meth-acrylic acid

$$(CH_2{=}\underset{\displaystyle CH_3}{\underset{|}{C}}{-}COOH)$$

are included. Specific acrylic esters suitable for formulation of the copolymers include the methyl, ethyl, propyl, isopropyl, butyl, isobutyl, hexyl, *t*-butyl, 2-ethyl-hexyl, decyl, lauryl, and stearyl esters of acrylic or methacrylic acids. It will be obvious to those skilled in the that the alkyl portion of the alkyl acrylate may also have, if desired, certain simple substituents which do not substantially interfere with the formation of the copolymers, nor detract from their desirable properties. Presently, the preferred alkyl esters are the lower alkyl esters of simple acrylic acids, for example, methyl, ethyl and butyl acrylates and methacrylates.

The preferred copolymer is ethylene-ethyl acrylate copolymer containing from 5% to 40% by weight of ethyl acrylate. One particularly preferred copolymer is ethylene-ethyl acrylate copolymer containing from 10% to 20% by weight of ethyl acrylate. Another particularly preferred copolymer is ethylene-ethyl acrylate copolymer containing $\geq 5\%$ and $\leq 18\%$, desirably $\leq 10\%$, by weight of ethyl acrylate.

The ethylene-alkyl acrylate copolymers generally have a density (ASTM 1505 test procedure with conditioning as in ASTM D-148-72) of from 0.92 to 0.94 grams/cc and a melt index (ASTM D-1238 at 44 psi. tested pressure) of from 1 to 50 decigrams per minute.

The ethylene polymers can be cured by irradiation with high-energy electron beams or through the use of chemical curing agents.

The art of electron beam crosslinking is so highly developed that one skilled in the art is very familiar with this procedure.

The chemical curing agent is preferably an organic peroxide. The organic peroxide curing agent which can be used in the present invention includes all organic peroxides which are capable of providing free radicals for cross-linking the ethylene polymer under the cross-linking conditions employed for the compositions.

The organic peroxide compounds can be used individually or in combination with one another.

The preferred organic peroxide compounds which may be used in the compositions of the present invention may also be generally classified as those in which each oxygen atom of each peroxide group is directly bonded to a tertiary carbon atom, the remaining valencies of which are attached to hydrocarbon radicals consisting of alkyl, cycloalkyl, aryl and aralkyl

groups. Peroxides of this type are generally disclosed in United States Patent No 2,888,424. Examples of the organic peroxide compounds which may be used in the vulcanizable compositions of the present invention include:-

di-α-cumyl peroxide
2,5-dimethyl-2,5-di(*t*-butyl peroxy)-hexyne-3
2,5-dimethyl-2,5-di(*t*-butyl peroxy)-hexane
t-butyl cumyl peroxide
di-*t*-butyl peroxide
α, α′-bis(t-butyl peroxy)-*p*-di-isopropyl benzene
2,5-dimethyl-2,5-di(benzoyl peroxy)-hexane
t-butyl peroxy isopropyl carbonate.

Additionally, organic hydroperoxide compounds, as disclosed in United State Patents Nos 3,954,907 and 4,018,852, are suitable for use in the present invention. Also, crosslinking aids (or boosters) for peroxides such as allyl compounds, for example, triallyl cyanurate, may be used herein.

The organic peroxide compounds are used in crosslinking-effective amounts in the compositions of the present invention which may range from 0.1 to 8.0 parts by weight, and preferably from 0.3 to 5.0 parts by weight, of organic peroxide compound per 100 parts by weight of ethylene polymer in these compositions.

The hydrated aluminum oxide filler used in the present invention is commercially available in different forms and grades. The hydrated aluminum oxide filler may have an average particle size of between 0.5 and 50 microns. For maximum flammability resistance and for optimum dispersion one generally desires to be within this range.

$$R_aSiX_{4-a}$$

wherein R is a lower alkyl, lower alkenyl, or lower alkynyl group; X is an alkoxy or alkoxyalkoxy radical containing from 1 to 20 carbon atoms, and *a* is 1 or 2. The term "lower" herein refers to groups having up to 4 carbon atoms. Preferably R is a lower alkenyl group and *a* is 1.

Specific examples of these silanes include methyltriethoxy-; methyltris (2 methoxyethoxy)-, dimethyldiethoxy-, vinyltris (2-methoxyethoxy)-, vinyltri-methoxy- and vinyltriethoxy- silane.

The preferred silanes are the following:

gamma-Methacryloxypropyltrimethoxy-silane

$$H_2C=\overset{\overset{\displaystyle CH_3}{|}}{C}-\overset{\overset{\displaystyle O}{\|}}{C}-O(CH_2)_3Si-(OCH_3)_3$$

and Vinyl-Tris (Beta-Methoxyethoxy) silane

$$H_2C=CHSi\ (OCH_2CH_2OCH_3)_3$$

The compositions of the present invention also advantageously include from 0.01 to 3.0, and preferably from 0.05 to 1.0 parts by weight of one or more suitable high temperature antioxidants for the ethylene polymer per 100 parts by weight of the ethylene polymer.

These antioxidants are preferably sterically hindered phenols or amines. The compounds include:-

1,3,5-trimethyl-2,4,6-tris (3,5-ditertiary butyl-4-hydroxy benxyl) benzene;
1,3,5-tris (3,5-ditertiary butyl-4-hydroxy benzyl)-5-triazine-2, 4, 6-(1H, 3H, 5H) trione.
tetrakis- [methylene-3-(3′, 5-di-*t*-butyl-4′-hydroxy phenyl)-propionate] methane; and di(2-methyl-4-hydroxy-5-*t*-butyl phenyl)sulfide.

Polymerized 1,2-dihydro-2,2,4-trimethylquinoline may also be used.

The antioxidants may be used individually, or in combination with one another.

In addition to the ethylene-alkyl acrylate copolymer, and silane-treated hydrated aluminum oxide filler, the compositions of the present invention may also contain other adjuvants of the types normally used in curable compositions for electric insulation.

These other adjuvants include curing agents; antioxidants; other fillers; flowing agents; nucleating agents for blown systems; UV stabilizers; dyes and colorants; voltage stabilizers; metal deactivators, coupling agents; and lubricants such as fatty acid soap or metallic derivatives thereof. Such a material is also important to improve the stripping properties of wire insulation and thereby to permit the insulation to be easily stripped from the wire by the user to facilitate splicing and to make terminations. Acceptable soaps are the alkaline

earth metal fatty acid soaps. A preferred soap is calcium stearate. Additional examples of useful lubricants include the alkaline earth metal salts and aluminum salts of stearic acid, oleic acid, palmitic acid and other fatty acids used by the art for this purpose, and silicone oil.

These adjuvants would be used in amounts designed to provide the intended effect in the resulting composition.

The compositions of the present invention may also be extended, or filled, with polymers other than the ethylene-alkyl acrylate copolymer which are compatible, i.e., can be physically blended or alloyed, with the ethylene-alkyl acrylate copolymer. The resulting compositions should contain at least 30 weight percent of ethylene-alkyl acrylate copolymer in all the polymers that may be present in the compositon, based on the total weight of the resulting composition. Some of the other polymers which may be used include polyvinyl chloride and polyproplene.

The total amount of adjuvants used will range from 0 to 60 weight percent, based on the total weight of the composition.

Preferably, when used to coat electrical conductors, all the components of the present invention are blended or compounded together prior to their introduction into an extrusion device from which they are to be extruded onto an electrical conductor. The ethylene-alkyl acrylate copolymer and the other desired constituents may be blended together by any of the techniques used in the art to blend and compound thermoplastics to homogeneous masses.

The recited silane and hydrated aluminum oxide can be blended intimately to coat the silane onto the surface of the aluminum oxide. Thereafter the silane/filler and the other additional components were added to the polymer and blended therewith. Care should be taken to control the temperature rise during the mixing so as to not activate the peroxide prior to the completion of blending. Alternatively, a master batch containing the polymer and the aluminum oxide filler and, if desired, some or all of the other components, may be added to the mass of polymer. It is important in this method, however, to withold addition of stearate to allow perferential coating of the filler by the silane. Introduction of silane and stearate simultaneously will lead to inferior overall mechanical properties.

Where the ethylene-alkyl acrylate copolymer is not available in powder form, the compositions may be made by introducing the polymer to the mill, masticating it until it forms a band around roll, after which a blend of the remaining components is added and the milling continued until an intimate mixture is obtained. The rolls are preferably maintained at a temperature which is within the range 80°C. to 150°C. and which is below the decomposition temperatures of the peroxide compound(s). The composition, in the form of a sheet, is removed from the mill and then brought into a form, typically dice-like pieces, suitable for subsequent processing.

After the various components of the compositions of the present invention are uniformly admixed and blended together, they are preferably further processed, in accordance with the process of the present invention, in conventional extrusion apparatus at about 120 to 160°C.

After being extruded onto a wire or cable, or other substrate, the compositions of the present invention are vulcanized at elevated temperatures of about $\geq$ 180°C. and preferably at $\geq$ 215-230°C. using conventional vulcanizing procedures.

In the following Examples, Examples 2, 6 to 8, and 10 to 13 illustrate the present invention. All parts are given as parts by weight.

Examples 1-2

The compositons of these Examples were prepared by mixing all of the components together in a Banbury mixer.

The formulations of the compositions are set forth in Table I.

TABLE 1

	1	2
Ethylene-ethyl acrylate copolymer (a)	43.2	42.7
Hydrated aluminum oxide	55.0	55.0
Vinyl-tris (beta-methoxyethoxy) silane	-	1.5
Antioxidant (b)	0.8	0.8
Triallyl cyanurate	0.5	0.5
Peroxide (c)	0.5	0.5
	100	100

(a) 17-20% by weight ethyl acrylate; Melt Index 4.5;
(b) polymerized 1,2-dihydro-2,2,4-trimethylquinoline:
(c) α, α' - bis (t-butyl-peroxy) diisopropylbenzene.

The compositions in Table I were processed into test specimens as required by the following test procedures and subjected to the following tests: Tensile strength and Elongation: ASTM-D412-68.

The results of these tests are set forth in Table II.

TABLE II

	Original		After heat aging 1 week at 150°C.	
Example	Tensile Strength (psi)	Elongation (%)	Tensile Strength (psi)	Elongation (%)
1	1020	160	1270	163
2	1940	200	1990	203

These results indicate that the addition of silane to the formulation increases original tensile strength and elongation as well as increasing tensile strength and elongation after heat aging.

Examples 3-8

The compositions of these Examples were prepared by mixing all of the components (except stearate) together in a Banbury mixer. The components were intimately mixed and after fluxing of the resin, the calcium stearate was added to the mix. The stearate was added last to allow preferential coating of the hydrated aluminum oxide filler by the silane.

The formulations of the composition are set forth in Table III.

TABLE III

	3	4	5	6	7	8
Ethylene-Vinyl Acetate Copolymer:						
(1) 28% by weight vinyl acetate; Melt Index 20.0	41.80	---	---	---	---	---
(2) 10% by weight vinyl acetate; Melt Index 3.0	---	41.80	---	---	---	---
(3) 18% by weight vinyl acetate; Melt Indes 2.5	---	---	41.80	---	---	---
Ethylene-Ethyl Acrylate Copolymer						
(1) 18% by weight ethyl acrylate; Melt Index 4.5	---	---	---	42.13	---	---
(2) 18% by weight ethyl acrylate; Melt Index 1.5	---	---	---	---	42.13	---
(3) 18% by weight ethyl acrylate; Melt Index 21.0	---	---	---	---	---	42.13
Hydrated Aluminum oxide	54.71	54.71	54.71	54.22	54.22	54.22
Vinyl-tris (beta-methoxyethyoxy) silane	1.00	1.00	1.00	1.00	1.00	1.00
Calcium stearate	1.00	1.00	1.00	0.80	0.80	0.80
Antioxident (a)	0.85	0.85	0.85	0.85	0.85	0.85
Triallyl cyanurate	0.32	0.32	0.32	0.50	0.50	0.50
Peroxide (b)	0.32	0.32	0.32	0.50	0.50	0.50
	100	100	100	100	100	100

(a) Polymerized 1,2-dihydro-2,3,4 triemethylquinoline; (b) 1,2-bis(t-butylperoxy) diisopropylbenzene

The compositions in Table III were processed into test specimens as required by the following test procedures and subjected to the following tests:

Tensile strength and elongation

ASTM-D412-68

Monsanto Rheometer Cure

This test procedure is fully set forth in U.S. Patent 4,018,852 issued April 19, 1977, which patent is incorporated herein by reference. Briefly, Figure 1 of said patent shows the typical Monsanto Registered Trade Mark rheometer curve. The optimum cure level (highest crosslink density) is designated as H. It is measured in terms of inch-pounds of torque on the rheometer test equipment. A higher value for H corresponds to a higher cross-link density.

The time, in minutes, required to reach 90% of the maximum cure (H) is designated as C_t. The scorch time, S_t, is defined as the point in time, in minutes, at which the curve reaches a rheometer level of 10 inch-pounds of torque on the upswing of the curve.

In general, one is interested in getting to the maximum cure (H) as soon as possible. In other words, a short C_t is desirable. At the same time, one would like S_t to be as long as possible since a longer S_t means the vulcanizable composition being evaluated can be processed at higher speed or at a higher temperature. That is, it would be less scorchy.

Brabender Scorch Time

A constant weight of material is added to a Brabender mixer maintained at 150°C and 40RPM and suitably adapted so that a torque measurement can be continuously measured on the material.

When the material reaches 135°C, torque measurement begins as measured by a Brabender Plastograph Recorder. Torque continues to decrease until a significant degree of cross-linking is occurring at which time torque measurement begins increasing. At the time that the torque curve intersects the zero point, scorch is considered to have occurred. The width of a bowl shaped curve described by the Plastograph Recorder is the scorch time measurement in minutes. The wider the bowl of this curve, the less is the scorching.

1% Secant Modulus

ASTM-D882-75B. The lower the secant modulus, the more flexible is the wire coating.

The results of these tests are set forth in Table IV.

TABLE IV

Example	Original Tensile Strength (psi)	Elongation(%)	Monsanto H. (in-lbs)	Rheometer Ct (mins)	Brabender Scorch time (min)	Base Resin Secant Modules (psi)	Compound Secant Modulus (psi)
3	2070	243	118	4.9	8.4	3,180	12,000
4	1990	213	82	5.7	4.5	9,180	28,400
5	2180	267	114	4.5	4.2	5,370	18,800
6	2070	210	100	5.7	5.5	5,330	12,900
7	2130	213	106	5.6	3.3	5,850	16,200
8	1770	203	86	6.6	6.7	4.650	14,800

The data in this Table shows that both the ethylene-vinyl acetate copolymer and ethylene-ethyl acrylate copolymer based resins have comparable tensile properties; slightly higher elongation with the ethylene-vinyl acetate copolymers; slightly longer cure times with the ethylene-ethyl acrylate copolymer (C_t). Also, cure time indicates that both polymer systems have similar processing characteristics. The secant modulus indicates that more flexible formulations occur with the ethylene-ethyl acrylate copolymers, notwithstanding the fact that the copolymers of Examples 5 (ethylene-vinyl acetate copolymer) and 6 (ethylene-ethyl acrylate copolymer) both have almost identical base resin secant modulus values.

Examples 9-11

The compositions of these Examples were prepared by the methods of Examples 3-8. The formulations of these compositions are set forth in Table V.

TABLE V

	9	10	11
Ethylene-Vinyl Acetate Copolymer (a)	43.65	-	-
Ethylene-Ethyl Acrylate Copolymer (b)	-	41.85	41.85
Hydrated Aluminum Oxide	55.00	54.40	54.40
Vinyl-tris (beta-methoxyethoxy) silane	0.50	1.50	1.50
Antioxidant (c)	0.85	0.85	-
Calcium stearate	-	0.90	0.90
Triallyl cyanurate	-	0.50	0.50
Antioxidant (d)	-	-	0.85
Peroxide (e)	0.65	0.50	0.45
Peroxide (f)	-	-	0.19
	100	100	100

(a) 18% by weight vinyl acetate; Melt Index 2.5;
(b) 17.6% by weight ethyl acrylate, Melt Index 1.2;
(c) polymerized 1,2-dihydro-2,2,4 trimethylquinoline;
(d) tetrakis [methane 3-(3',5'-di-tertbutyl-4'-hydroxyphenyl) propionate] methane;
(e) α,α' -bis(t-butylperoxy) diisopropylbenzene.
(f) di-α-cumyl peroxide.

The compositions in Table V were processed into test specimens as required by the following test procedures and subjected to the following tests: Tensile strength and elongation, ASTM-D412-68; Shore D hardness ASTM-D2240-75; Secant modulus, ASTM-D882-758; Density ASM-D1505-68; Brittle temperature ASTM-D746-73; Tensile strength and elongation (as above, under heat aging conditions); Monsanto Rheometer (as previously described); Brabender scorch time (as previously described); Flame Tests, as described.

The results are set forth in Table VI.

TABLE VI

Example	9	10	11
Physical Properties			
Tensile strength, psi	2,430	2,030	2,190
Elongation, %	253	233	220
Shore D hardness	47	47	49
Secant modulus, psi	19,000	17,400	17,800
Density, g/cc	1.406	1.398	1.419
Brittle temperature, °C	−55.0	−52.0	−50.5
Heat aging:			
tensile strength, psi./elongation, %			
7 days, 158°C	2600/220	2260/233	2390/200
Monsanto Rheometer			
H (cure level) in-lbs,	111.6	121.6	122.0
S_T (scorch time), mins	1.05	1.30	1.38
C_T (cure time), mins	5.65	5.15	5.55
E $\binom{\text{Efficiency}}{\text{Factor}} = \frac{HS_T}{C_T - S_T}$	13.65	20.52	20.19
Brabender Scorch Time mins	4.1	6.0	8.2
Flame Tests			
SAE J 878a AUTOMOTIVE[1]	Pass	Pass	Pass
UL 788 APPLIANCE[1]	Pass	Pass	Pass
CSA APPLIANCE[1] flame test	Pass	Pass	Pass

[1]These tests are conducted on an 18 gauge cooper stranded conductor (16 strands) having 0.030″ insulation.

A comparison of the data indicates similar physical properties with both copolymer systems, with the exception of slightly lower tensile strength and elongation with the ethylene-ethyl acrylate copolymer system (Examples 10 and 11). However, the compositions of the present invention (Examples 10 and 11) exhibit greater flexibility as shown by the lower secant modulus values. The Monsanto Rheometer data as well as the Brabender scorch time data indicate the compositions of the present invention (Examples 10 and 11) are superior to an ethylene-vinyl acetate copolymer system (Example 9) in scorch resistance. Heat aging data as well as flammability data is comparable between the two resin systems.

Examples 12-13

The compositions of these Examples were prepared by the methods of Examples 3-8. The formulations of the compositions are set forth in Table VII.

TABLE VII

	12	13
Ethylene-Ethyl Acrylate Copolymer (a)	41.85	-
Ethylene-Ethyl Acrylate Copolymer (b)	-	41.85
Hydrated Aluminum Oxide	54.40	54.40
Vinyl-tris (beta-methoxyethoxy) silane	1.50	1.50
Antioxidant (c)	0.85	0.85
Calcium stearate	0.90	0.90
Triallyl cyanurate	0.50	0.50
Peroxide (d)	0.50	0.50
	100	100

(a) 20.35% by weight ethyl acrylate, Melt Index 4.8;
(b) 17.60% by weight ethyl acrylate, Melt Index 1.2;
(c) polymerized 1,2-dihydro-2,2,4 trimethylquinoline;
(d) α, α' - bis(t-butylperoxy) diisopropylbenzene.

The compositions of Table VII were subjected to a pinch test (per SAE J878a) as follows; A 36" cable is placed taut across a 1/8" steel rod and is subjected to the force of a weighted steel anvil which applies an increasing force at the rate of 5 lbs./minute. At the moment the insulation is pinched through, the 1/8" rod contacts the sample conductor and the test stops. For an 18 gauge wire with a conductor diameter of approximately 0.040" and an insulation thickness of 0.030", the minimum resistance required to pass this test is 16 foot-lbs.

The results of this test are set forth in Table VIII.

TABLE VIII

Example	12	13
Pinch resistance, ft-lbs.	14-14.5	18-18.5

It can be seen from the data in the table that a composition which contains ≥ 18% of ethyl acrylate in the ethylene-ethyl acrylate copolymer is more pinch resistant than a copolymer which contains greater than 18% of ethyl acrylate.

WHAT WE CLAIM IS:-

1. A curable composition suitable for electrical coating applications comprising an ethylene-alkyl acrylate as hereinbefore defined copolymer and a hydrated aluminum oxide treated with at least one silane of the following formula:

$$R_aSiX_{4-a}$$

wherein R is a lower alkyl, lower alkenyl or lower alkynyl group (the term "lower" being as hereinbefore defined), X is an alkoxy or alkoxyalkoxy group containing from 1 to 20 carbon atoms, and a is 1 or 2.

2. A composition as claimed in claim 1 wherein R is lower alkenyl group and a is 1.

3. A composition as claimed in claim 1 or claim 2 wherein the silane is vinyl - tris(beta-methoxyethoxy) silane.

4. A composition as claimed in any one of the preceding claims wherein the silane is present in an amount of from 0.5 to 5.0 parts by weight of silane per 100 parts by weight of hydrated aluminum oxide.

5. A composition as claimed in claim 4 wherein the silane is present in an amount of from 1.0 to 3.0 parts by weight of silane per 100 parts by weight of hydrated aluminum oxide.

6. A composition as claimed in any one of the preceding claims wherein the hydrated aluminum oxide is present in an amount of from 80 to 400 parts by weight per 100 parts by weight of the ethylene-alkyl acrylate copolymer.

7. A composition as claimed in claim 6 wherein the hydrated aluminum oxide is present in an amount of from 100 to 150 parts by weight per 100 parts by weight of the ethylene-alkyl acrylate copolymer.

8. A composition as claimed in any one of the preceding claims wherein the ethylene-alkyl acrylate copolymer is an ethylene-ethyl acrylate copolymer.

9. A composition as claimed in claim 8 wherein the ethylene-ethyl acrylate copolymer

contains from 5% to 40% by weight of ethyl acrylate.

10. A composition as claimed in claim 9 wherein the ethylene-ethyl acrylate copolymer contains from 10% to 20% by weight of ethyl acrylate.

11. A composition as claimed in claim 8 wherein the ethylene-alkyl acrylate copolymer is an ethylene-ethyl acrylate copolymer containing $\geqslant$ 5% and $\leqslant$ 18% by weight of ethyl acrylate.

12. A composition as claimed in claim 11 wherein the ethylene-ethyl acrylate copolymer contains $\geqslant$ 5% and $\leqslant$ 10% by weight of ethyl acrylate.

13. A composition as claimed in claim 1 substantially as hereinbefore described.

14. A composition as claimed in claim 1 substantially as hereinbefore described in any one of Examples 2, and 6 to 8.

15. A composition as claimed in claim 1 substantially as hereinbefore described in any one of Examples 10 to 13.

16. A composition as claimed in any one of the preceding claims when vulcanized.

17. An electrical wire or cable when insulated with a vulcanized composition as claimed in claim 16.

18. An automotive wire when insulated with a vulcanized composition as claimed in claim 16.

19. An appliance wire when insulated with a vulcanized composition as claimed in claim 16.

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